Monopoles and Family Replicated Unification

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Abstract

The present theory is based on the assumption that at the very small (Planck scale) distances our space-time is discrete, and this discreteness influences on the Planck scale physics. Considering our (3+1)-dimensional space-time as a regular hypercubic lattice with a parameter $a = \lambda_{\rm P}$, where $\lambda_{\rm P}$ is the Planck length, we have investigated a role of lattice artifact monopoles which is essential near the Planck scale if the Family replicated gauge group model (FRGGM) is an extension of the Standard Model at high energies. It was shown that monopoles have N times smaller magnetic charge in FRGGM than in SM (N is the number of families in FRGGM). These monopoles can give an additional contribution to beta-functions of the renormalisation group equations for the running fine structure constants $\alpha_{{\rm i}(\mu)}$ (i=1,2,3 correspond to the U(1), SU(2), and SU(3) gauge groups of the Standard Model). We have used the Dirac relation for renormalised electric and magnetic charges. Also we have estimated the enlargement of a number of fermions in FRGGM leading to the suppression of the asymptotic freedom in the non-Abelian theory. Different role of monopoles in the vicinity of the Planck scale gives rise or to AntiGUT, or to the new possibility of unification of gauge interactions (including gravity) at the scale $\mu_{\rm GUT}{\approx}10^{18.4}$ GeV. We discussed the possibility of the $[{\rm SU}(5)]^3$ SUSY or $[{\rm SO}(10)]^3$ SUSY unifications.

1. Introduction

Trying to look insight the Nature and considering the physical processes at very small distances, physicists have made attempts to explain the well–known laws of low–energy physics as a consequence of the more fundamental laws of Nature. The contemporary physics of the electroweak and strong interactions is described by the Standard Model (SM) which unifies the Glashow-Salam-Weinberg electroweak theory with QCD – theory of strong interactions.
The gauge group of symmetry in the SM is :

$$SMG = SU(3)_{\mathrm{c}\times SU(2)_{\mathrm{L}\times U(1)_{\mathrm{Y},}}}(1)$$

which describes the present elementary particle physics up to the scale ≈ 100 GeV.
Recently it was shown in a number of papers [**?**] that the family replicated gauge groups of type :

We see that the family replicated gauge groups provide a new way to stabilize the Higgs mass in the Standard Model.

2. Family Replicated Gauge Group

The extension of SM with the Family Replicated Gauge Group (FRGG):

$$G = (SMG)^N = [SU(3)_{\mathrm{c}]^N\times[SU(2)_{\mathrm{L}]^N\times[U(1)_{\mathrm{Y}]^N}}}(2)$$

was first suggested by C.D.Froggatt and H.B.Nielsen [**?**].
In Eq.(2) N designates the number of quark and lepton families. If $N = 3$ (as experiment confirms), then the fundamental gauge group G is:

$$G = (SMG)^3 = SMG_{1\text{st fam.}\times SMG_{2\text{nd fam.}\times SMG_{3\text{rd fam..}}}}(3)$$

The generalized fundamental group:

$$G_{\mathrm{f}=(SMG)^3\times U(1)_{\mathrm{f}}} \tag{4}$$